

ABSTRACT OF THE DISCLOSURE

We disclose a method of applying a sculptured layer of material on a semiconductor feature surface using ion deposition sputtering, wherein a surface onto which the sculptured layer is applied is protected to resist erosion and contamination by impacting ions of a depositing layer, said method comprising the steps of: a) applying a first portion of a sculptured layer with sufficiently low substrate bias that a surface onto which said sculptured layer is applied is not eroded away or contaminated in an amount which is harmful to said semiconductor device performance or longevity; and b) applying a subsequent portion of said sculptured layer with sufficiently high substrate bias to sculpture a shape from said the first portion, while depositing additional layer material. The method is particularly applicable to the sculpturing of barrier layers, wetting layers, and conductive layers upon semiconductor feature surfaces and is especially helpful when the conductive layer is copper. In the application of a barrier layer, a first portion of barrier layer material is deposited on the substrate surface using standard sputtering techniques or using an ion deposition plasma, but in combination with sufficiently low substrate bias voltage (including at no applied substrate voltage) that the surfaces impacted by ions are not sputtered in an amount which is harmful to device performance or longevity. Subsequently, a second portion of barrier material is applied using ion deposition sputtering at increased substrate bias voltage which causes resputtering (sculpturing) of the first portion of barrier layer material, while enabling a more anisotropic deposition of newly depositing material. A conductive material, and particularly a copper seed layer applied to the feature may be accomplished using the same sculpturing technique as that described above with reference to the barrier layer.